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(54) Title of Invention Process for the Production of Hollow-Fiber Filtration Membrane Module

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Specification

1. Title of the Invention

Process for the Production of Hollow-Fiber Filtration Membrane Modulus

2. Patent Claim

A process for the production of a hollow-fiber filtration membrane modulus characterized by installing small holes at the bottom surface of a container; inserting rods or tubes, which have the same cross-sectional shape as that of the small holes and nonstick surface, into the holes; inserting a prescribed number of hollow fibers into the container from its opening; filling the container with a cross-linking resin not covering the rods or tubes completely; after bonding and sealing the hollow fibers by carrying out cross-linking and curing of the resin, removing the rods or tubes to form through holes; and meanwhile, bonding the other ends of the hollow fibers with a resin, etc., while holding the hollow fibers in their open state.

3. Detailed Explanation of the Invention

Hollow fiber filtration membranes (called hollow fibers, below) have high membrane-packing density enabling to make a small and light-weight filtration device, and consequently, they have been used widely in the fields of pure water manufacturing, food processing, etc.

In general, the stock solution for filtration is pressure-fed inside hollow fibers, and the filtrate is collected outside of the hollow fibers in many cases, but if only a trace amount of microparticles is to be removed from a relatively clear stock solution, the filtration method, so-called external pressure method feeding the stock solution from the outside of hollow fibers and collecting the filtrate inside them is advantageously used to carry out efficient filtration procedures.

When the filtration is carried out conventionally by using a system such as the one described above, a module, which is prepared by bundling a multiple number of hollow fibers and cutting open at least one of their ends after bonding and sealing both ends with a resin, is installed in a cylindrical container in a manner that both inside and outside of the hollow fibers are liquid-tight, the stock solution for filtration is pressure-fed from the side of the cylinder to the outside of the hollow fibers, and the filtrate seeping through into the inside of the hollow fibers is collected from their open ends.

In the process described above, the pressurized stock solution for filtration pressed the hollow fiber bundle. Those hollow fibers inside the bundle were liable to come into close contact with one another with adjoining hollow fibers, and consequently, they were prevented from coming into contact with the stock solution for filtration. Therefore, only those hollow fibers at the outer portion of the bundle were contributing to the filtration, and there was a shortcoming of poor filtration efficiency.

To eliminate this shortcoming, a filtration device as the one shown in Figure 1 has been proposed.

Figure 1 is a schematic drawing showing the cross section of the filtration device of this invention. One end of a hollow fiber bundle 2 is sealed and bonded with a resin 3, but this resin has a prescribed number of through holes 5 open to the inside of the hollow fiber bundle 2. The other ends of the hollow fibers are bonded in an open state to make a module, which is installed in a housing 4

so that both inside and outside of the hollow fibers are liquid-tight. The housing 4 is allowed to have an inlet 1 for the filtration stock solution to be pressure-fed, the outlet for the filtrate and air-discharging valve 8 is installed.

To carry out filtration procedures in a filtration device configured as described above, the stock solution for filtration is fed from the inlet 1 to the inside of the hollow fiber bundle 2 through the through holes 5. As a result, the filtration is carried out while the hollow fiber bundle 2 is not being tightened up from the outside but rather being expanded from the inside. Consequently, those adjoining hollow fibers are allowed to come into contact with the stock solution for filtration without coming into any close contact with one another. Therefore, all of the hollow fibers constituting the bundle are allowed to contribute in the filtration procedures without any waste, and the filtration efficiency can be drastically improved. The filtrate seeping through the inside of the hollow fibers is discharged from the filtrate outlet 7.

The through holes 5 are also useful for introducing air or other gas, and thus, generating air bubbles inside the container 4 to allow the hollow fibers to vibrate.

In a filtration device having the structure as described above, it is essential to have a prescribed regular configuration of the through holes 5 on the inside of the hollow fiber bundle 2. However, the process achieving it had extremely difficult procedures requiring a great deal of time and efforts.

As a result of studies carried out diligently, the inventors of this invention arrived successfully at this invention, therefore, it has become easy to produce a module such as the one described.

Specifically, this invention is a process for the production of a hollow-fiber filtration membrane modulus characterized by installing small holes at the bottom surface of a container; inserting rods or tubes, which have the same cross-sectional shape as that of the small holes and nonstick surface, into the holes; by inserting a prescribed number of hollow fibers into the container from its opening; by filling the container with a cross-linking resin to the extent not to cover the rods or tubes completely; after bonding and sealing the hollow fibers by carrying out cross-linking and

curing of the resin, removing the rods or tubes to form through holes; and meanwhile, bonding the other ends of the hollow fibers with a resin, etc., while holding the hollow fibers in their open state.

This invention is explained specifically in detail with an application example as follows.

The hollow fibers used were 800 strands of polysulfone hollow fiber having an inner diameter of 1.0 mm, outer diameter of 1.6 mm, length of 130 mm and initial water permeability of 1200 $L/m^2 \cdot h \cdot atm$.

The bottom surface 12 of an acrylic cylinder 9, having an inner diameter of 74 mm, an outer diameter of 78 mm and a height of 30 mm as shown in Figure 2, as a container was allowed to have 9 small holes 10 of 3 mm in diameter formed radially, and a Teflon rod 11 of 3 mm in diameter that was inserted into each small hole. The shape of the container is not necessarily limited to a cylinder, but if necessary, it is possible to use a box shape or other shape. It is also possible to use the housing 4 shown in Figure 1 as a container after installing a bottom on one end. The material for the rod or tube to be inserted to each of those small holes is not necessarily limited to Teflon, and it is possible to use other materials such as polyolefin resin with a nonstick surface, resin with a mold-releasing surface treatment, etc.

After aligning one end of the hollow fiber bundle by cutting, the hollow fibers are uniformly inserted into the container as shown in Figure 3. Because of the positions of the through holes 5 being specified by the rods 11, it was extremely easy to insert the hollow fiber bundle 2 uniformly. After feeding an epoxy resin from the opening of the container and carrying out cross-linking curing to bond and seal the hollow fiber bundle, the rods 11 were removed from the bottom to form through holes 5. In this case, it is essential for the epoxy resin not to cover the rods 11 completely when it is fed to the container so that the holes formed penetrate through the layer of the resin formed.

The other end of the hollow fiber bundle is cut to a required length, the conventional method was carried out to bond the hollow fibers in an open state by molding an epoxy resin in a cylindrical shape of 78 mm in diameter and about 30 mm long, and the total length of the module was set to 1060 mm.

The module prepared as described above was placed in a poly(vinyl chloride) housing of 80 mm inner diameter and 88 mm outer diameter, and the two ends were sealed liquid-tight to the housing.

The housing configured as described above was allowed to have an inlet for the filtration stock solution and filtrate outlet at the ends, an air-discharging valve was installed, and as a result, a filtration device having a configuration similar to that shown in Figure 1 was prepared.

The filtration device prepared was found to have those through holes in a required constant configuration, and the hollow fibers were found to be uniformly distributed. Therefore, the stock solution for filtration was uniformly fed to each of those hollow fibers allowing all of them to contribute to the filtration procedures. Consequently, it was confirmed that it is possible to carry out highly efficient filtration. Therefore, the process for the production of this invention is considered very simple and useful for highly efficient filtration.

4. Brief Explanation of Drawings

Figure 1 is a drawing schematically showing a cross section of the filtration device of this invention. In the figure, 1: filtration stock solution inlet, 2: hollow fiber bundle, 3: cross-linking resin bonding and sealing hollow fibers, 4: housing, 5: through hole, 6: cross-linking resin bonding and sealing open end of hollow fibers, 7: filtrate outlet and 8: air discharge valve.

Figure 2 is a drawing schematically showing an acrylic container used in the application example of this invention, A shows a side-view cross-sectional drawing, and B shows the bottom surface. In the figure, 9: acrylic resin container, 10: small hole, 11: Teflon round rod inserted into a small hole 10 and 12: container bottom surface.

Figure 3 is a drawing schematically showing the state of inserting round rods into small holes of an acrylic container and one end of hollow fibers uniformly, and filling the container with a cross-linking resin and the subsequent state of the rod being removed after curing of the cross-linking resin to form a through hole.

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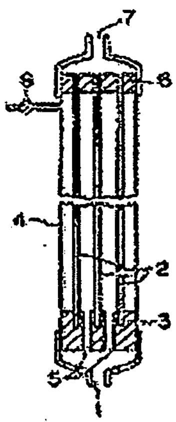

Figure 1

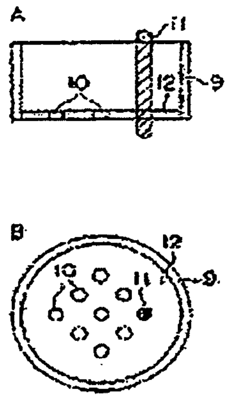

Figure 2

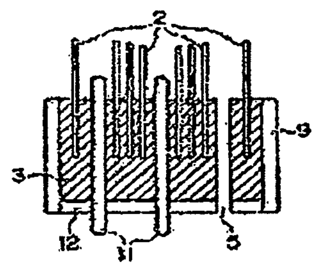

Figure 3